Dames & Moore Job No. 04010-090-06

Salt Lake City, Utah

September 26, 1985

WATER QUALITY AND SALT BALANCE ESTIMATES
PROPOSED RESERVOIR IN NORTH PAGUATE PIT
JACKPILE-PAGUATE URANIUM MINE
FOR ANACONDA MINERALS COMPANY

Dames & Moore

620350

Dames & Moore

250 East Broadway, Suite 200
Salt Lake City, Utah 84111
(801) 521-9255
Cable address: DAMEMORE

September 26, 1985

Anaconda Minerals Company
Uranium Division
P. O. Box 638
Grants, New Mexico 87020

Attention: Mr. Chris Sanchez

Gentlemen:

WATER QUALITY AND SALT BALANCE ESTIMATES
PROPOSED RESERVOIR IN NORTH PAGUATE PIT
JACKPILE-PAGUATE URANIUM MINE
FOR ANACONDA MINERALS COMPANY

INTRODUCTION

This letter presents the results of water balance and salt balance calculations performed to estimate hydrologic effects of the establishment of a proposed reservoir in the North Paguate pit as part of Anaconda's Multiple Use Reclamation Plan.

ASSUMPTIONS AND APPROACH

We have assumed that the reservoir would be designed as outlined in the report "North Paguate Pit Study, Jackpile-Paguate Uranium Mine Reclamation Project, Cibola County, New Mexico," dated May 31, 1985, by Michael Baker, Jr., Inc., Aurora, Colorado. Plate 1 presents area-capacity curves for the proposed reservoir.

We have used the assumptions and approach discussed in our report "Water and Salt Balance Estimates, Evaluation of Hydrologic Effects, Jackpile-Paguate Uranium Mine, For Anaconda Minerals Company," dated September 25, 1985. Table 1 summarizes hydrologic values utilized for our water balance calculations.

WATER BALANCE

At present, ground water inflow to the North Paguate pit is at a rate of about 78 acre-feet per year, principally from flow from river alluvium through backfill at the west end of the pit. Upon reservoir filling, hydraulic gradients will be much smaller into the pit and the seepage rate into the reservoir will decrease. We estimate ground water inflow will be on the order of 30 acre-feet per year with the reservoir full based upon average hydraulic conductivity and head conditions. Ground water outflow will also occur from the eastern end of the pit with the reservoir full. We estimate outflow to be between 5 and 10 acre-feet per year through Jackpile Sandstone based upon average hydraulic conductivity and head conditions in the Jackpile Sandstone.

Assuming average climatic conditions, reservoir filling would take about two years if 392 acre-feet per year of stream water could be diverted from the Rio Paguate, as assumed by Baker (1985). This assumes one-third of the Rio Paguate-Rio Moquino annual flow could be diverted into the reservoir for the filling period. Whether this rate of stream flow could be diverted for filling over this period of time will depend upon downstream water uses and water rights.

Table 2 gives a water balance for average future conditions assuming the Rio Paguate is diverted through the reservoir at the 392 acre-foot/year rate. As shown by the figures on Table 2, evaporation from the reservoir would diminish total inflow by about 89 acre-feet per year, or about 20 percent.

SALT BALANCE

The salinity of the reservoir upon filling will depend upon the length of time before it is filled since time will control how much ground water enters, how much evaporation occurs, etc. Once filled, salt which has built up in the reservoir will be swept out by flow through the reservoir. In the long-term, salinity will be principally dependent upon the quality of the Rio

Paguate inflow since it is the major component of the total water inflow. Ground water quality is also an important factor since ground water concentrations are high relative to other inflows to the reservoir.

Assuming reservoir filling is started three years from now and is completed five years from now, salt concentrations in the reservoir with time are estimated to be as shown on Table 3. Plate 2 shows graphically the changes in total dissolved solids (TDS) and sulfate (SO_4) concentrations with time. These assume surface water runoff from the reclaimed area has a concentration equal to one-half that measured in Pond Y in 1982, ground water has a concentration equal to that measured in Seep X in 1982, and the Rio Paguate has a concentration equal to that measured at station RP-104 by Hydro-Search in 1980 (Hydro-Search, 1981, Table 3). These concentrations are summarized on Table 4. Table 4 also summarizes steady-state concentrations for a diversion of 392 acre-feet per year.

Total dissolved solids will decrease to 923 ppm and sulfate will decrease to 397 ppm in the long-term as shown on Table 4. These concentrations meet general water use criteria such as those cited in the New Mexico Environmental Improvement Division ground water quality standards. Although these standards are not applicable to the reservoir from a regulatory standpoint, they are useful for comparison purposes and are also shown on Table 4. Heavy metals (barium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel, silver, vanadian, zinc), arsenic, and selenium concentrations measured in ground water, ground water in backfill, ponded water in the pits, and in the Rio Paguate upstream of the proposed reservoir, as reported in Dames & Moore (1983) and Hydro-Search (1981), were at or below detection limits and met N.M.E.I.D. ground water quality standards for human health, domestic use and irrigation. Waters in the proposed reservoir should therefore be suitable from a chemical and radiological standpoint.

In the long-term, reservoir water quality should improve even further since ground water in the backfill and runoff will revert to natural quality.

Some five to six years would be required to establish near-steady-state water quality conditions in the reservoir after filling and twenty years would be required to establish complete steady-state.

CONCLUSIONS

The North Paguate pit could be converted to a suitable water storage reservoir. Water quality of the reservoir should be suitable for long-term use for irrigation and stock watering.

Very truly yours,

DAMES & MOORE

Larry T. Murdock
Partner

George W. Condrat
Geological Engineer

LTM/GWC:si

Attachments

TABLE 1

HYDROLOGIC VALUES ASSUMED FOR WATER BALANCE CALCULATIONS

Precipitation Rate:	11.5 inches/year
Runoff Rate (reclaimed condition):	0.13 inches/year
Pan evaporation Rate:	67. inches/year
Pan Coefficient	0.67
Lake Evaporation Rate	45. inches/year
Potential Evapotranspiration (reclaimed condition without phreatophytes):	24. inches/year
Disturbed Drainage Area to Reservoir	284 acres
Average Annual River Inflow Available:	394 acre-feet/year
Ground Water Inflow Rate:	100 acre-feet/year at pond elevation 5870
	30 acre-feet/year at pond elevation 5935
Ground Water Outflow Rate:	0 acre-feet/year at pond elevation 5900
	10 acre-feet/year at pond elevation 5935

TABLE 2

RESERVOIR WATER BALANCE -
RECLAIMED CONDITION IN LONG-TERM

	North Paguate Reservoir
Disturbed Drainage Area to Reservoir (acres)	284
Reservoir Area (acres)	32
Net Reservoir Evaporation (acre-feet/year)	89.3
Storage Increase (acre-feet/year)	0
Runoff to Reservoir (acre-feet/year)	2.7
Ground Water Inflow (acre-feet/year)	30
Ground Water Outflow (acre-feet/year)	10
River Inflow (acre-feet/year)	392
River Outflow (acre-feet/year)	325.4

TABLE 3

RESERVOIR ELEVATION AND QUALITY VS TIME
PROPOSED NORTH PAGUATE RESERVOIR

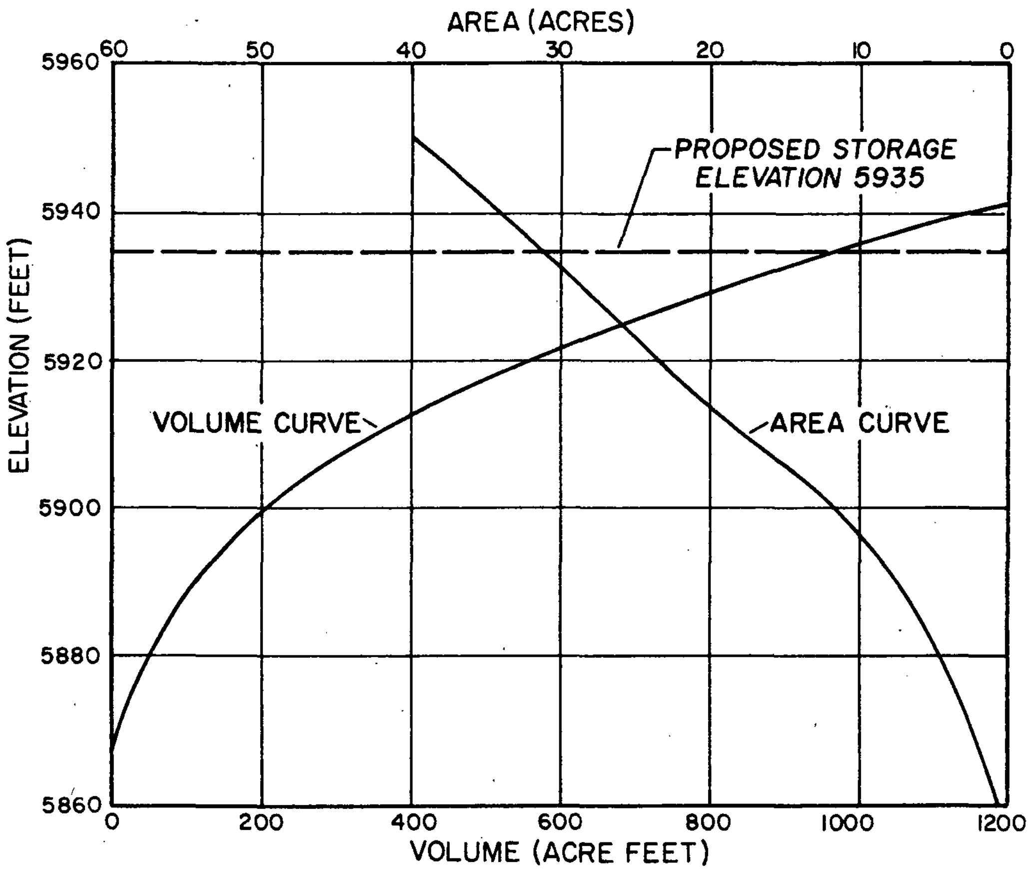
TIME (yr)	ELEVATION (ft)	CONCENTRATION TDS (ppm)	SO4 (ppm)	Cl (ppm)	Na (ppm)	Ca (ppm)	U (ppm)	Ra-226 (pCi/l)
0.5	5902.7	3452.3	2466.5	26.8	540.0	309.7	5.5	45.5
1.0	5903.3	3630.3	2575.5	27.6	551.0	333.9	5.6	50.7
1.5	5904.0	3797.6	2678.6	28.3	562.2	356.3	5.7	55.4
2.0	5904.5	3956.5	2777.3	29.1	573.5	377.2	5.8	59.8
2.5	5905.1	4108.8	2872.6	29.8	584.9	397.0	6.0	63.9
3.0	5905.6	4256.1	2965.3	30.5	596.4	415.9	6.1	67.8
3.5	5906.0	4399.3	3055.8	31.3	608.1	434.0	6.2	71.5
	(Start filling reservoir)							
4.0	5915.1	3095.3	2072.1	23.3	411.8	311.7	4.0	47.9
4.5	5923.7	2531.2	1644.0	20.0	326.8	258.7	3.1	37.6
5.0	5931.7	2213.9	1401.2	18.1	279.0	228.9	2.6	31.6
5.5	5935.0	2008.7	1242.7	17.0	248.1	209.6	2.2	27.6
	(Reservoir full)							
6.0	5935.0	1849.6	1119.2	16.1	224.0	194.9	1.9	24.4
6.5	5935.1	1713.6	1013.5	15.4	203.5	182.1	1.7	21.7
7.0	5935.1	1597.5	923.3	14.8	186.0	171.1	1.5	19.4
7.5	5935.2	1498.5	846.3	14.3	171.1	161.7	1.3	17.5
8.0	5935.2	1413.9	780.6	13.8	158.3	153.7	1.2	15.8
8.5	5935.2	1341.6	724.4	13.4	147.4	146.9	1.1	14.3
9.0	5935.3	1279.9	676.4	13.1	138.1	141.0	0.9	13.1
9.5	5935.3	1227.2	635.4	12.8	130.2	136.1	0.9	12.1
10.0	5935.3	1182.1	600.4	12.6	123.4	131.8	0.8	11.2
10.5	5935.4	1143.6	570.4	12.4	117.6	128.2	0.7	10.4
11.0	5935.4	1110.7	544.8	12.2	112.6	125.0	0.7	9.8
11.5	5935.4	1082.5	522.9	12.1	108.4	122.4	0.6	9.2
12.0	5935.4	1058.4	504.1	11.9	104.7	120.1	0.6	8.7
12.5	5935.4	1037.8	488.1	11.8	101.6	118.1	0.5	8.3
13.0	5935.5	1020.1	474.3	11.7	99.0	116.5	0.5	7.9
13.5	5935.5	1005.1	462.6	11.7	96.7	115.1	0.5	7.6
14.0	5935.5	992.1	452.5	11.6	94.7	113.8	0.5	7.4
14.5	5935.5	981.1	443.9	11.5	93.1	112.8	0.4	7.2
15.0	5935.5	971.6	436.5	11.5	91.7	111.9	0.4	7.0
15.5	5935.5	963.5	430.2	11.4	90.4	111.1	0.4	6.8
16.0	5935.6	956.6	424.8	11.4	89.4	110.5	0.4	6.7
16.5	5935.6	950.6	420.1	11.4	88.5	109.9	0.4	6.6
17.0	5935.6	945.5	416.2	11.3	87.7	109.4	0.4	6.4
17.5	5935.6	941.2	412.8	11.3	87.1	109.0	0.4	6.4
18.0	5935.6	937.4	409.8	11.3	86.5	108.7	0.4	6.3
18.5	5935.6	934.2	407.3	11.3	86.0	108.3	0.4	6.2
19.0	5935.6	931.5	405.2	11.3	85.6	108.1	0.3	6.2
19.5	5935.6	929.1	403.3	11.3	85.2	107.9	0.3	6.1
20.0	5935.6	927.1	401.7	11.2	84.9	107.7	0.3	6.1
20.5	5935.6	925.4	400.4	11.2	84.7	107.5	0.3	6.0
21.0	5935.6	923.9	399.2	11.2	84.5	107.4	0.3	6.0
21.5	5935.6	922.6	398.2	11.2	84.3	107.2	0.3	6.0
22.0	5935.6	921.5	397.3	11.2	84.1	107.1	0.3	6.0
22.5	5935.7	920.6	396.6	11.2	84.0	107.1	0.3	5.9
23.0	5935.7	919.8	396.0	11.2	83.8	107.0	0.3	5.9
23.5	5935.7	919.1	395.4	11.2	83.7	106.9	0.3	5.9
24.0	5935.7	918.5	394.9	11.2	83.6	106.9	0.3	5.9
24.5	5935.7	918.0	394.5	11.2	83.6	106.8	0.3	5.9
25.0	5935.7	917.5	394.2	11.2	83.5	106.8	0.3	5.9

TABLE 4

WATER QUALITY OF INFLOWS AND STEADY-STATE CONCENTRATION IN POND
PROPOSED NORTH PAGUATE RESERVOIR

	CONCENTRATION						
	TDS (ppm)	SO_4 (ppm)	Cl (ppm)	Na (ppm)	Ca (ppm)	U (ppm)	Ra-226 (pCi/l)
Initial Concentration In Pond (11-84)	3260	2350	26	529	283	5.36	39.7
Ground Water Inflow Concentration	3098	2060	17	340	349	3.52	65.1
Runoff to Reservoir Concentration	448	270	45	110	22	1.3	4
Rio Paguate Inflow to Reservoir Concentration	549	392	8	45	65	0	0.09
Steady-State Concentration in Reservoir	923	397	11	84	107	0.3	6
New Mexico Standards*	1000	600	250	NA	NA	5.	30.

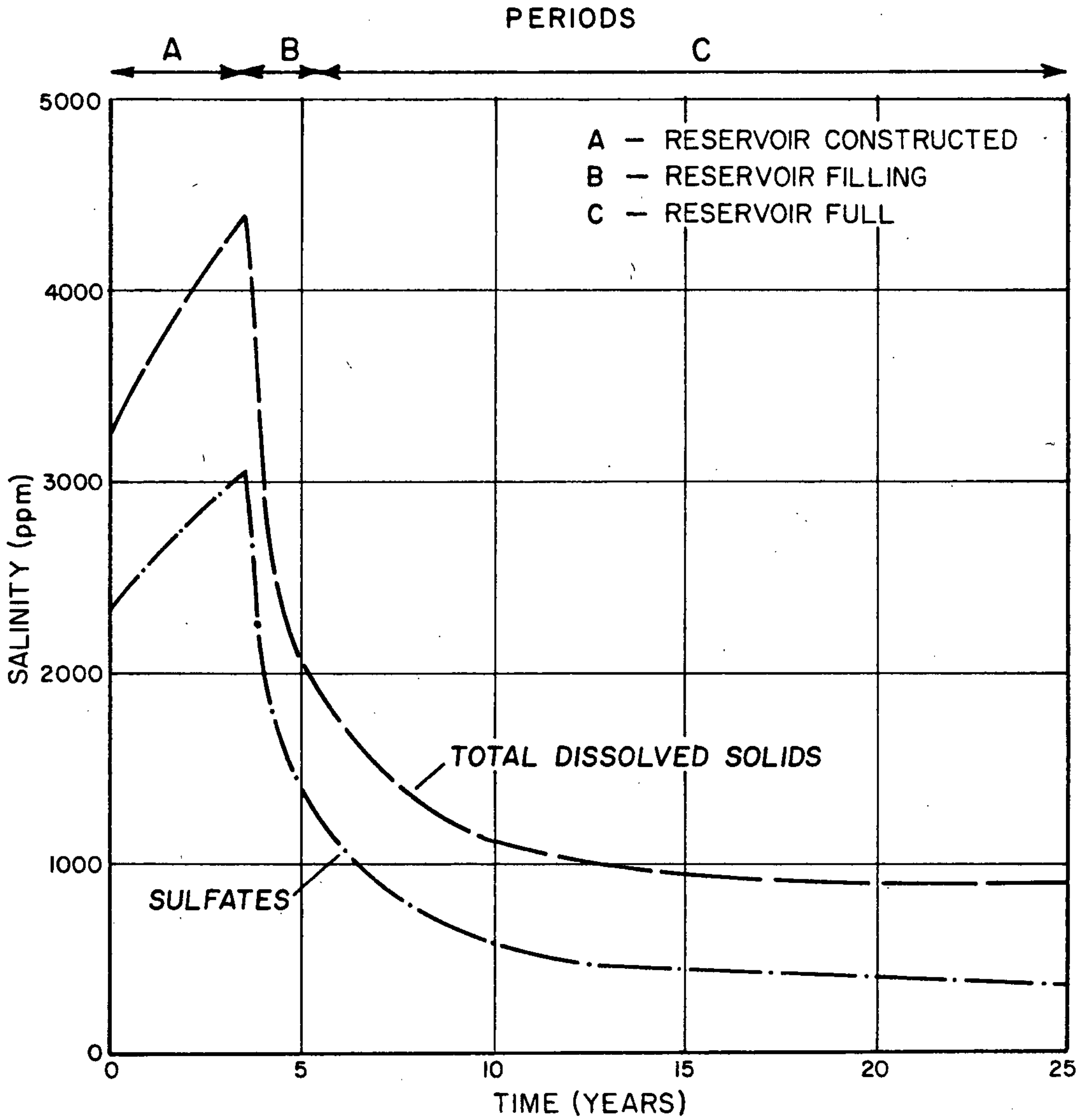
* New Mexico Standards for Human Health and Domestic Water Supply from New Mexico ground water quality regulations



AREA-CAPACITY CURVES
PROPOSED NORTH PAGUATE RESERVOIR

SOURCE: Michael Baker, Jr., Inc. (1985).

Dames & Moore



SALINITY vs. TIME
PROPOSED NORTH PAGUATE RESERVOIR

Dames & Moore

PLATE 2